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WHAT IS GEOGRAPHIC INFORMATION AND GIS

Geographic information is a significant subset of the information explosion that has occurred over the last two decades. In the broadest sense, geographic information is information that includes a locational/spatial reference (street address, latitude/longitude, section/township) as part of the data records. According to the Urban and Regional Information Systems Association, more than 80 percent of all the information used by local governments is geographically (or spatially) referenced.

Location, or place, is an important component of the vast majority of information which state and local government collects and uses in its day-to-day functioning. Just casual consideration of a wide range of government functions points to the importance of location: property records and assessment; highway and/or utility planning, construction and management; public health, welfare and safety planning and management; economic development efforts; natural resource planning and management, etc. Location is also very important to a wide variety of private enterprises such as farming, trucking, real estate, banking and business siting decisions.

The geographic component of information has become increasingly important as information technologies, such as Geographic Information Systems (GIS), have been developed to analyze and display information based on its location. GIS is a computer-based software that integrates the maps (spatial/graphical component) and database (tabular alpha-numeric component) aspects of information. A GIS is designed for the collection, storage and analysis of phenomena where geographic location is an important characteristic or critical to the analysis. GIS should not be confused with a related technology, GPS (Global Positioning System) which uses satellite signals to determine one's position or location on the earth's surface. GPS receivers are frequently used in conjunction with a GIS to determine the location (or coordinates) of features so that these coordinates can then be entered into a GIS for display or analysis of those features.

In general, the most effective and efficient GIS is one that is integrated with the rest of an organization's information technology (hardware, software and databases) and one that is shared and/or coordinated across multiple agencies. The power of GIS is most apparent when the quantity of data involved is too large to be efficiently handled manually. There may be thousands of features to be considered, and hundreds of factors associated with each feature or location. This information may be stored on a multitude of maps, paper tabular files, computerized databases, and/or large lists of names and addresses. With GIS, all of this information can be brought into the same system and the interrelationships of the numerous features and their characteristics analyzed as they relate to a given problem.

The availability of GIS has increased the importance and utility of the geographic component of the information that governments routinely collect and maintain. GIS adds a powerful package of tools to an organization's information technology capability because of its ability to integrate and analyze diverse types of information based on the physical location or proximity of the various features or characteristics.

Graphical Display of Data and Its Implications. One of the most powerful capabilities of a GIS is its ability to graphically display data or information related to public policy decisions. The capability to link tabular data to related maps or other graphic displays of the data is a powerful communication tool that turns raw data into useable information. In most cases, a picture is indeed worth a thousand words. A color-coded map showing high crime areas is a much more powerful statement than a tabular set of data containing the same information. Likewise, a property parcel map with all of the taxed parcels colored in green and three untaxed parcels colored in red clearly communicates the situation.

Neighborhood Analysis. Another powerful capability of a GIS is the ability to identify and/or analyze phenomenon based on their physical proximity or being in the same neighborhood. The spatial or locational component of GIS enables the user to accomplish several types of analyses or applications that would be difficult without reference to location. As an example, a GIS could be used to help determine the least risky route for the shipment of hazardous materials. One could use a GIS to define a buffer strip with a given width along the various possible routes and select the route that has the least number of schools, hospitals and traffic accidents within the buffer zone.

Overlay Analysis. Within a GIS, this locational or physical proximity information can also be used to overlay several different types of information and analyze their interaction as it relates to a given problem. Figure II-1. illustrates how this overlay technique might be applied to analyze the potential for soil erosion.

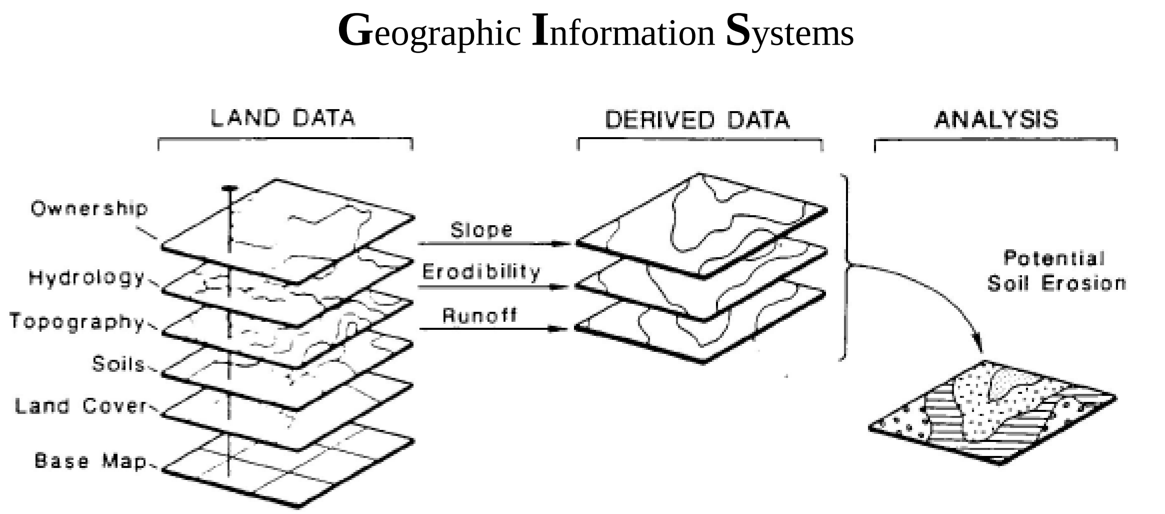

Figure II-1. Illustration of Overlay capabilities of Geographic Information Systems (GIS)

As is common in GIS, the different types of information relevant to a particular problem are organized into separate digital data layers. In this case the information categories and corresponding data layers are: Ownership, Hydrology, Topography, Soils, Land Cover, and Base Map. These data layers contain information about the characteristics of a particular feature (such as soil type) and information about where that characteristic or feature is located. Conceptually, think of it as making several copies of a base map, which might contain just the section corners and roads. On one copy of the map you would mark and label the land ownership parcels. On another you would mark and label the hydrological features (streams, lakes, etc) and so forth for all the separate data layers.

To see how one type of feature, on one copy (or layer) of the map, might relate to another type of feature, on another copy (or layer), you could lay them on top of each other and shine a light through them. This would enable you to see though the top map and see the lines on the map(s) below. To ensure an accurate picture of the interrelationships of the various features, careful alignment of all the maps on top of each other would be necessary. On the light table you might do this by lining up two or three road intersections or section corners.

In a GIS, this "lining up" is done by referencing each data layer to a common spatial reference coordinate system, such as latitude & longitude. In Figure II-1., this common spatial framework is represented by the pin that sticks through all the layers. This feature of GIS allows information on completely different types of features, from different information sources, to be brought together and analyzed for how they might interact and impact on a particular phenomenon of concern — in this case the potential for soil erosion.

A similar approach could be used with GIS for a wide variety of types of data layers and a wide variety of applications. For example, one might map optimum sites for potential manufacturing plant development based on the interaction of data layers such as: streets and highways, railroads, utilities, zoning, vacant lots, distance to suppliers, location of trained workforce, etc.

Storing and Retrieving Maps. The analytical capabilities outlined above are powerful and commonly used tools of GIS. However, one of the most frequently utilized capabilities of GIS is its ability to store, modify and retrieve maps digitally. Much of the day-to-day work of government involves maps, thousands of maps. The information on these maps is constantly changing, requiring the maps to be modified or completely redrawn to keep current. This is a very expensive, labor and time consuming process. In addition, one department may produce a given map and it may be used by another department, whose latest version of the map may no longer be up-to-date. This can lead to costly errors and lost time for all involved.

GIS allows these maps to be stored digitally and updated on an on-going basis. These digitally stored maps can be printed out to produce an up-to-date version upon request either by the department that maintains the map information or by another department that shares a common computer network. Specific attribute information about a given feature on a map, such as the traffic volume on a given road, can also be accessed via computer. This fundamental capability of GIS can provide a great deal of increased efficiency, and eliminate unnecessary redundancy in many governmental operations.

Components of a GIS. GIS is a complex ***system*** and, as such, it requires more than just the ***hardware*** (computers, etc) and ***software*** (computer programs) to make it function. Two other types of components are necessary for any successful GIS: ***information or data*** in the proper form; and the ***agencies and trained people*** working together to make a GIS a success. Indeed, most GIS analysts would assert that the most challenging aspects of building a successful GIS are the development and maintenance the proper data and securing the cooperation of multiple agencies and retaining trained, experienced people.

What are the Applications of Geographic Information Systems. Geographic information systems were initially developed primarily for use in the area of natural resources management. However, as the software's capabilities and the understanding of the technology has grown, the use of GIS has now expanded to include a wide and rapidly growing range of applications. Some of the more common areas of government/public applications of GIS include the following:

- Assessment
- Planning and zoning
- Natural resources management
- Transportation planning and maintenance
- Health and public safety
- Utilities planning and service
- Economic development
- Disaster planning and response
- Apportionment (school, fire, legislative districts)
- School bus and other routing

In all of these applications, the location of some features or characteristics in relation to other features is an important consideration. A GIS allows a user to associate this feature location information with other types of information that are important relative to the particular application. For example, in both assessment and natural resources management applications the location of soil types relative to property parcels is an important consideration. In planning and zoning applications, the location of animal confinement facilities relative to residential areas might be considered important. In public safety applications, the spatial pattern of crimes or accidents may provide an important clue for solving outstanding crimes or preventing future crimes or accidents. In most of these applications, the bulk of the information is collected and stored via traditional information technology. It is the GIS and the geographic component of the information, which is collected and referenced in a consistent manner, which facilitates the consideration of the spatial component of the information.

An Example ¾ Applications and Benefits for a County Assessor. While the above material provides a general overview of the capabilities and benefits of GIS, a closer look at one specific area of local government application (assessment) provides a more detailed perspective of the benefits an assessor might expect from the technology. If GIS technology investments are carefully implemented, they can greatly assist County Assessors in the performance of their duties, as well as numerous other local and state agencies.

While GIS technology offers many benefits and tools to an assessor, it is important to note that it is not a replacement for a Computer Aided Mass Assessment (CAMA) program. GIS, if developed carefully, can be integrated with a CAMA program and enhance overall assessment efforts. Among the applications and tools that a GIS offers a County Assessor are the following:

Inventory of Parcels on Tax Rolls. Because of its graphical component, a GIS is powerful tool to ensure that all property parcels are currently included on the tax rolls.

Integrating Multiple Factors for Valuation. GIS provides tools to directly assist the assessment process by integrating a variety of factors that might influence value. Some of the key characteristics which can be associated with a property through their spatial relationship with that property are as follows:

- soils
- comparable sales within a given distance
- zoning
- water, streams, and flood plains
- area or size
- land use

Utilizing Spatial Relationships in Equalization Analyses. For example, a properly configured GIS could, with relative ease, select all the property parcels within a 20 miles radius of a given point that are of a certain area, soil type, level of water development, and sold within a specified period.

Reduce the Number of Tax Protests. The ability of GIS technology to provide a graphic, visual display of the characteristics (such as soil type, size, comparable value, etc.) that were used to determine the valuation for a given property parcel reduces the likelihood that an owner will file a tax protest.

Updating and Maintaining Property Parcel Maps. Once such maps have been carefully developed initially within a GIS, current, accurate parcel maps can be maintained with relative ease and modest expense.

Easier Retrieval and Display of Property Information. A considerable amount of time is spent in an assessor's office performing the repetitive tasks involved in retrieving information related to property parcels. A GIS provides excellent tools to facilitate these tasks.

Common Assessment, Equalization and Mapping Procedures Statewide. The development of standards and guidelines for GIS implementation for assessment purposes could provide a vehicle for the evolution of more uniform assessment, equalization and property parcel mapping procedures statewide — at both the local and state level.

Provide Policy Makers with Insights on Implications of Policy Decisions. The ability of a GIS to graphically display the results (or potential results) of policy decisions related to assessment and tax policy provides policy makers with valuable tools to model and visualize the implications of policy decisions.

Cooperative Development and Maintenance of Property Ownership Maps and Records. Property parcel maps, and related information about land ownership, are needed by multiple local, state, and federal agencies for a wide variety of applications. Currently many agencies maintain separate property parcel maps, resulting in a poor utilization of public funds through duplication of efforts and policy making based on conflicting information. Examples of some of the applications needing property parcel data are listed below

- Assessment
- Natural resources management
- Farm planning
- Transportation planning and maintenance
- Public safety
- Planning and zoning
- Utilities planning and service
- Economic development
- Disaster planning and response

In summary, the material above provides an illustration of how GIS technology can be applied in one typical local government office. Numerous other applications are possible for other local government offices. An integrated, multi-agency GIS allows agencies to share data between agencies and frequently eliminates or minimizes existing duplication of efforts to maintain commonly needed datasets. This sharing of data also increases the probability of different agencies making policy decisions based on current and consistent information. The development of a local government GIS requires a significant investment of public resources. However, in many instances, some of the required resources are already being spent to perform applications that a GIS can perform more efficiently. Before such an investment is undertaken, efforts should be made to plan for how this investment could be used to meet the multipurpose needs and applications of multiple government agencies.

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